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An updated inventory of the vascular flora of the Cerbaie hills (Tuscany, Italy)

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Abstract

We present an updated list of the vascular flora occurring in the Cerbaie hills (Tuscany), a site of high naturalistic interest. The list is based on a literature survey and on field studies carried out in the years 2010–2022. The Cerbaie hills host a flora of 1,107 specific and subspecific taxa (including 100 naturalized aliens), 32 casual aliens and 10 hybrid taxa. Two taxa are new for Tuscany: *Carex oedipostyla* and *Thalictrum simplex* subsp. *galioides*; 330 taxa are new for the study area. Concerning old records, 344 have been confirmed, while 47 were not confirmed, albeit considered reliable. Moreover, we considered three taxa as locally extinct, 19 as doubtfully occurring, and three as wrongly reported. Despite the low elevation of the study area, life forms and chorotypes show marked Eurosiberian affinities, in agreement with the temperate and continental climate.

Keywords

alien species, biodiversity, endemics, floristic data, phytogeography

Introduction

A flora is a useful source of information for biogeographical, ecological and evolutionary studies (Peruzzi 2018; D'Antraccoli et al. 2022), so that floristic inventories are crucial to provide suitable data for decision-making processes in biodiversity conservation and

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landscape planning (Carta et al. 2018). One of the most important naturalistic areas in Tuscany (central Italy) are the Cerbaie hills, which also represent a Special Area for Conservation (SAC code IT5170003) according to the European Union's Habitats Directive.

The first floristic records for these hills can be found in Caruel (1860–1864, 1866–1870). Then, Sandri and Fantozzi (1895) provided abundant information, also cited by Baroni (1897–1908). Di Moisè (1959) published a first floristic study of the area. In addition to her own collections and observations, she referred also to herbarium specimens preserved at the Herbarium of Firenze (FI). Later, Arrigoni (1997) carried out a vegetation study, and Tomei (2004) published a survey on the floristic peculiarities of the area. Interesting new floristic data were published by Bacci et al. (2008) and Lastrucci et al. (2008), and the occurrence of several noteworthy species was then published by Bernardini et al. (2013a, 2013b). Further floristic records devoted to single species were published by Fiori (1943), Di Moisè (1951), Del Prete (1978), Tomei and Pistolesi (1980), Tomei et al. (1986, 1991), Tomei and Guazzi (1993), Arrigoni and Menicagli (1999), Corsi and Magrini (2001), Pierini and Peruzzi (2005), La Rosa and Peruzzi (2007), Arrigoni (2018, 2019, 2020, 2021), Astuti et al. (2019), Peruzzi et al. (2017, 2019b, 2019c, 2021, 2022).

The aim of this study is to present a comprehensive analysis of previous literature, using an updated and coherent nomenclature, complemented by field investigations, to compile a floristic inventory of the vascular flora of the Cerbaie hills. It is part of a series of investigations carried out by the PLANTSEED Lab (Department of Biology, University of Pisa) devoted to improving the floristic knowledge of Tuscany (Pierini et al. 2008; Peruzzi et al. 2011; Gestri and Peruzzi 2012, 2013, 2014; Pierini and Peruzzi 2014; Ciccarelli et al. 2015; Gei et al. 2016; Roma-Marzio et al. 2016; Carta et al. 2018; Roma-Marzio et al. 2020; Peruzzi 2021, 2023).

Materials and methods

Study area

The Cerbaie are low hills (maximum elevation, reached in Montefalcone, is 117 m a.s.l.) that cover an area of ca. 114 km^2 in the middle portion of northern Tuscany (Fig. 1). These hills lie between the Bientina plain on the western side, the Fucecchio swamp on the northern and eastern side, and the Arno river on the southern side. The territories of seven municipalities are involved: Fucecchio (Firenze); Bientina, Calcinaia, Castelfranco di Sotto, Santa Croce sull'Arno, and Santa Maria a Monte (Pisa), and Altopascio (Lucca). A peculiarity of the territory is the abundant presence of streams and impluvia (locally called "vallini"), mostly oriented SE-NW.

From a geological perspective, the Cerbaie hills are constituted mainly by Pliocenic and Pleistocenic sedimentary rocks and sediments (AA. VV. 2009). Soils are more or less acid, deriving from siliceous substrates (Arrigoni 1997).

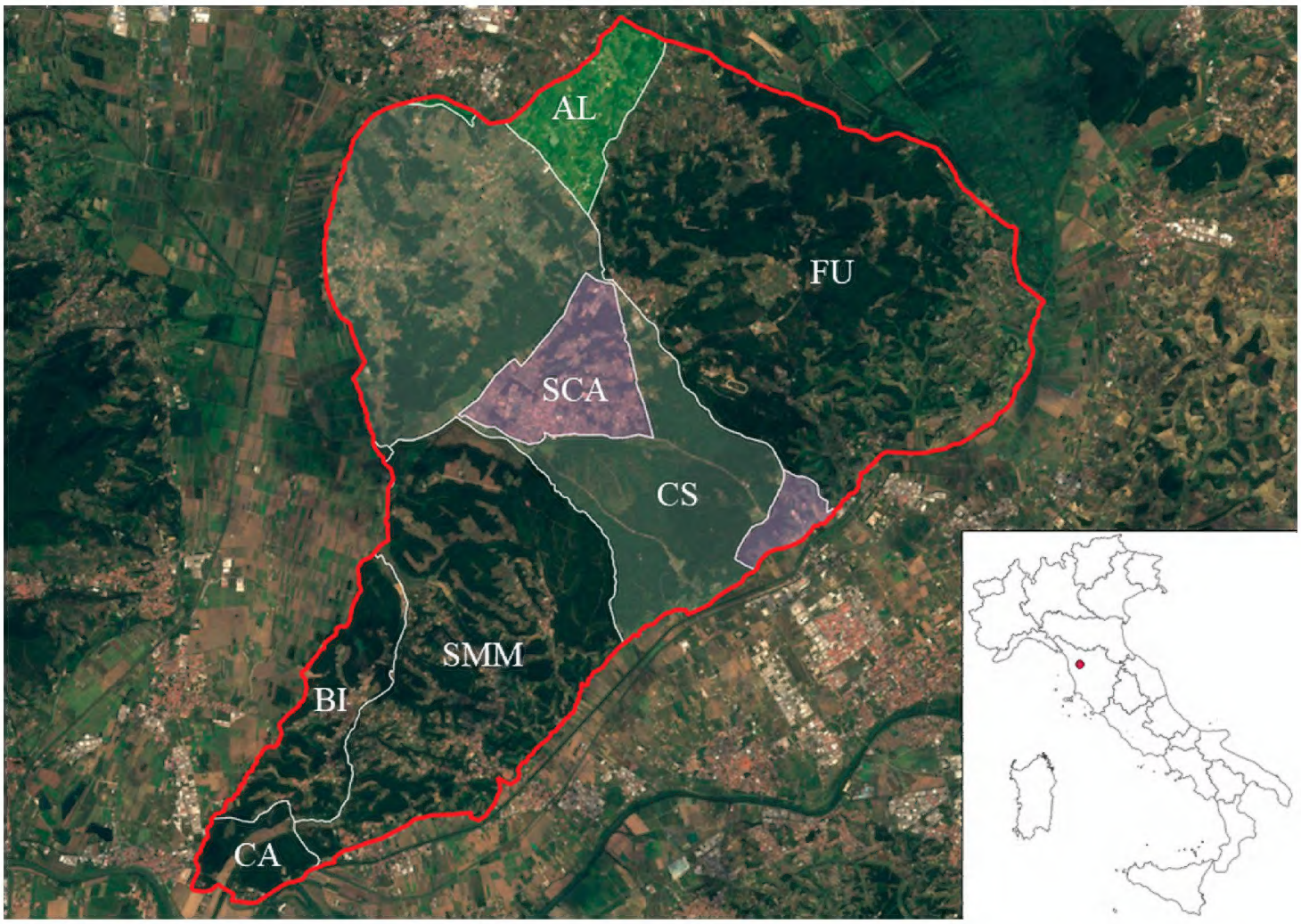

Figure 1. Localisaton of the Cerbaie hills in Italy. The red line circumscribes the study area. The different shades of colours identify disjunct territories belonging to the same municipality. AL = Altopascio (Lucca), CA = Calcinaia (Pisa), BI = Bientina (Pisa), SMM = Santa Maria a Monte (Pisa), SCA = Santa Croce sull'Arno (Pisa), CS = Castelfranco di Sotto (Pisa), FU = Fucecchio (Firenze).

The climate of the Cerbaie hills is temperate, continental and rather homogeneous (AA. VV. 2009), showing some degree of summer aridity, especially in July (Arrigoni 1997) and precipitation peaks in autumn and spring (mean annual precipitation 950–1100 mm; AA. VV. 2009).

Concerning vegetation and land use, the southern portions of the Cerbaie hills are dominated by olive orchards and cultivated fields; the rest of the territory is mostly covered by woods, which cover about 40% of the surface, where *Pinus pinaster* Aiton subsp. *pinaster* and the alien *Robinia pseudoacacia* L. are becoming particularly widespread in recent times (Piussi and Stiavelli 1995). Often mesophilous, meso-hygrophilous, and thermophilous species can be found growing very close to each other (Arrigoni 1997).

Most of the hills belong to the preapenninic acidophilous durmast oak vegetation series of plain areas from Tuscany and Umbria (*Hieracio racemosi-Querco petraeae sigmetum*), while surrounding areas belong to the peninsular hygrophilous *geosigmetum* of riparian vegetation (*Salicion albae*, *Populion albae*, *Alno-Ulmion*) (De Dominicis et al. 2010a, 2010b). For an in-depth syntaxonomic treatment of durmast oak woods, see Viciani et al. (2016, 2018) and Viciani (2023).

Floristic inventory

To obtain a 'working hypothesis' concerning the number of taxa expected in the study area, we used the approach followed by D'Antraccoli et al. (2019), which relied on species-area relationships (SARs) adjusted by environmental modeling. We searched all published papers dealing with plants of the Cerbaie hills and extracted occurrence records for all those species reported for the area. These data were complemented by field observations available in the portal Wikiplantbase #Toscana (Peruzzi and Bedini 2013 onwards) and our own field expeditions carried out from 2010 to 2022. The taxa reported by Sandri and Fantozzi (1895) were considered only when clearly referring to the Cerbaie hills. We did not consider the floristic list published by Guarino and Bernardini (2002), which also concerns the Cerbaie hills, because it was impossible to distinguish taxa occurring within the study area from those occurring in neighbouring areas.

Nomenclature and circumscription of the taxa follows Bartolucci et al. (2018), Galasso et al. (2018) and their updates periodically appearing in the Portal to the Flora of Italy (https://dryades.units.it/floritaly/index.php; Martellos et al. 2020). Angiosperm families are arranged according to APG IV (2016). Life forms and chorotypes were attributed according to Pignatti (2017a, 2017b, 2018), not considering casual aliens and cultivated species. Information about Italian endemics was derived from Peruzzi et al. (2014, 2015), and Bartolucci et al. (2018). We also highlighted those taxa included in the Italian Red List (Rossi et al. 2013, 2020). The OGUs were identified based on the different municipalities (Fig. 1). The complete dataset assembled for the present study is available in Suppl. material 1.

Results

Floristic inventory

The expected number of species/subspecies and alien taxa was 1,021 and 86, respectively.

A total of 1,107 specific and subspecific taxa currently occur in the study area, including 100 naturalized aliens, representing about 9% of the established flora, not considering casual aliens (32) and hybrid taxa (10); two are new records for Tuscany, and 330 are new for the Cerbaie hills. While 344 taxa have been directly confirmed during field surveys, 47 taxa reliably recorded in the past were not confirmed. We excluded three taxa, while three other taxa were considered as locally extinct and 19 as doubtfully occurring in the area.

Three families alone account for about 30% of the total vascular flora (Asteraceae 126 taxa, Fabaceae 112, and Poaceae 96), although Cyperaceae are also well represented (53). The most represented genera are *Trifolium* (35), *Carex* (20), *Lathyrus* (17), *Juncus*, and *Vicia* (15).

Biological and chorological spectra highlight that hemicryptophytes (35.2%), therophytes (32.2%), and geophytes (15.1%) are the most represented life forms,

followed by phanerophytes (11.7%), hydrophytes (3.1%), and chamaephytes (2.7%). As far as the chorological spectrum is concerned, Eurosiberian (32.5%) and transitional Eurosiberian-Mediterranean (25.5%) are the most frequent chorotypes, followed by wide distribution (16.5%) and Mediterranean (15.4%). Alien taxa represent 9% of the total flora.

Italian endemics are 13: *Cardamine apennina* Lihová & Marhold, *Crocus biflorus* Mill., *Hieracium grovesianum* Arv.-Touv. ex Belli, *Melampyrum italicum* (Beauverd) Soó, *Ornithogalum etruscum* Parl. subsp. *etruscum*, *O. etruscum* Parl. subsp. *umbratile* (Tornadore & Garbari) Peruzzi & Bartolucci, *Ophrys appennina* Romolini & Soca, *O. classica* Devillers-Tersch. & Devillers, *O. maritima* Pacifico & Soca, *Polygala flavescens* DC. subsp. *flavescens*, *P. nicaeensis* W.D.J.Koch subsp. *italiana* (Chodat) Arrigoni, *P. vulgaris* L. subsp. *valdarnensis* (Fiori) Arrigoni, and *Scabiosa uniseta* Savi. In addition, there is also a microspecies, putatively a narrow endemic to the study area, namely *Taraxacum cerbariense* Arrigoni. Three species recorded by previous authors were not found, and could be possibly extinct at the local level, i.e. *Lysimachia tenella* L., *Menyanthes trifoliata* L., and *Potentilla alba* L.

Discussion

With respect to the predicted richness based on SARs, the number of species/subspecies is 8% above the theoretical prediction. This suggests a high floristic richness of the study area, as compared with other areas in Tuscany (D'Antraccoli et al. 2019). However, it is noteworthy that also the number of alien taxa is 53% above the expected value. Accordingly, the number of aliens in the Cerbaie hills is relatively high, although there are floras of surrounding areas showing up to +207% of expected aliens, such as the municipality of Empoli (Peruzzi 2023). Among alien taxa, *Ailanthus altissima* (Mill.) Swingle is listed in European regulation UE 2019/1262.

Many of the taxa occurring in the Cerbaie hills are of high phytogeographical interest. *Drosera rotundifolia* L. is found at the southern margin of its distribution range, while other taxa can be found in Tuscany only in the Cerbaie hills (i.e. the new records *Carex oedipostyla* Duval-Jouve and *Thalictrum simplex* L. subsp. *galioides* (DC.) Korsh.) or still survive only there in Tuscany (*Exaculum pusillum* (Lam.) Caruel and *Gentiana pneumonanthe* L. subsp. *pneumonanthe*) (Peruzzi and Bedini 2013 onwards). There are species which usually grow at higher elevations, such as *Asphodelus macrocarpus* Parl. subsp. *macrocarpus*, *Betula pendula* Roth, and *Veratrum album* L.

Other rare species in Tuscany are: *Cardamine amporitana* Sennen & Pau, *Carex demissa* Hornem. subsp. *demissa*, *C. rostrata* Stokes, *Cicendia filiformis* L., *Cyperus michelianus* (L.) Link, *Dictamnus albus* L., *Hottonia palustris* L., *Hydrocotyle vulgaris* L., *Hypochaeris maculata* L., *Juncus heterophyllus* Dufour, *Lathraea clandestina* L., *Lysimachia minima* (L.) U.Manns & Anderb., *Lythrum tribracteatum* Salzm. ex Spreng., *Melampyrum pratense* L. subsp. *commutatum* (Tausch ex A.Kern.) C.E.Britton, *Nymphoides peltata* (S.G.Gmel.) Kuntze, *Solenopsis laurentia* (L.) C.Presl (also originally

described from this area, see Peruzzi et al. 2019a), *Thysselinum palustre* (L.) Hoffm., *Tripleurospermum inodorum* (L.) Sch.Bip., *Utricularia australis* R.Br., *Veronica scutellata* L., and *Viburnum opulus* L.

The taxa showing some conservation interest (Rossi et al. 2013, 2020) are 44, 27 of which are categorized as Least Concern, three Data Deficient, five Near Threatened (*Carex rostrata*, *Gladiolus palustris* Gaudin, *Osmunda regalis* L., *Utricularia australis*, and *Zannichellia palustris* L.), three Vulnerable (*Leucojum aestivum* L. subsp. *aestivum*, *Ranunculus ophioglossifolius* Vill., and *Thelypteris palustris*), and six Endangered (*Baldellia ranunculoides* (L.) Parl., *Cardamine amporitana*, *Exaculum pusillum*, *Hottonia palustris*, *Hydrocotyle vulgaris*, and *Sagittaria sagittifolia* L.) at national level.

Life forms and chorotypes show marked Eurosiberian affinities, despite the low elevation but in agreement with the temperate and continental climate. Comparing the flora of the Cerbaie hills with those of surrounding areas, in Monte Pisano (Pierini et al. 2009) and Empoli (Peruzzi 2023) the proportion of life forms is similar to the Cerbaie hills, while in Montalbano therophytes dominate and geophytes are more represented (Gestri and Peruzzi 2013). Concerning biogeographical affinities, a more abundant presence of Mediterranean species was recorded in Monte Pisano (Pierini et al. 2009) and in Empoli (Peruzzi 2023), while chorotypes transitional between Mediterranean and Eurosiberian regions dominate in Montalbano (Gestri and Peruzzi 2013).

Thanks to its rich and diversified flora, the Cerbaie hills stand out as one of the sites showing the highest phytogeographical and conservation interest in Tuscany.

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Supplementary material 1

Floristic list and records

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Data type: PDF file

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